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Natural gas, petroleum and coal are hydrocarbons with significantly different molecular weights and hydrogen to carbon ratios. Among the three conventional fossil fuels, coal is the most abundant and the cheapest, while petroleum is a most desirable fuel resource because it is easily processed into valuable petroleum products, especially gasoline and diesel. How to utilise coal resources, especially as a replacement of petroleum, is an important topic.

Significant resources have been devoted in research and development of technologies for production of petroleum substitute from coal. There are three technical routes to convert coal into petroleum substitute: Fischer-Tropsch (FT) process, direct coal liquefaction by hydrogenation, and pyrolysis. Among them, pyrolysis is a simple process with mild reaction conditions and low capital investment, but is with the disadvantage of a relatively low yield of total gas and liquid, below 50%. The main problem for a large scale commercialisation of this technology is an efficient utilisation of the liquefaction residue, i.e. char.

Integration of various industries can provide an ideal solution for efficient utilisation of coal. This includes processing coal by pyrolysis with production of liquid and solid fuel products, which can be further processed into final products in petroleum refining/petrochemical industry. The solid char generated in coal pyrolysis can be used in metallurgical industry, especially for injection in blast furnace ironmaking process. Char can also be used as fuel for power industry by replacing coal.

A schematic flowsheet of complex utilisation of coal in various industries is presented in Figure 1.

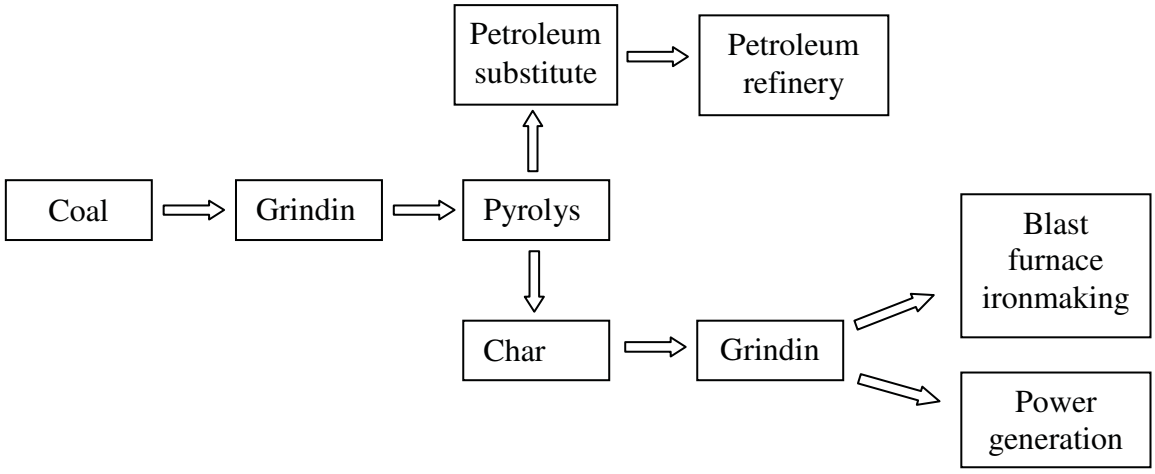
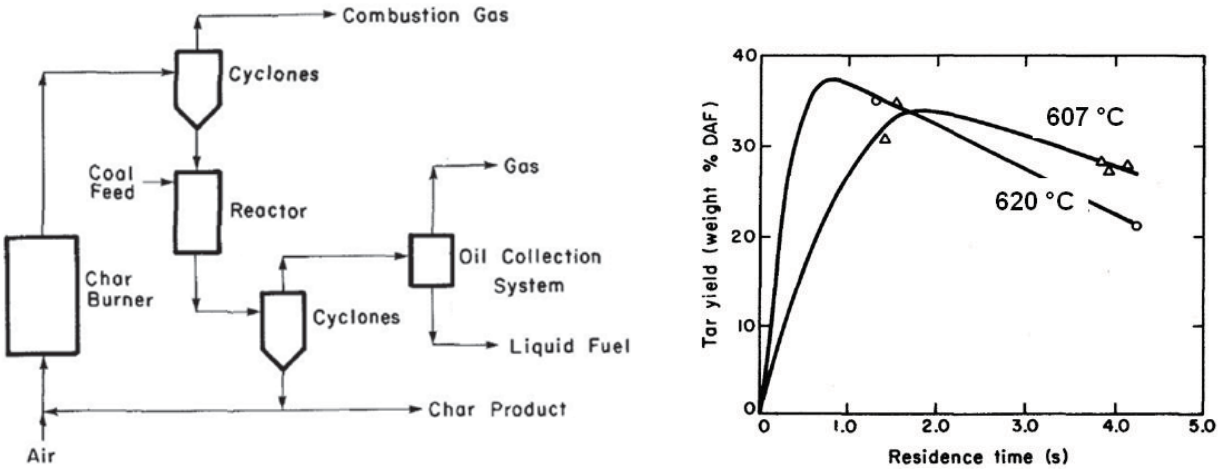


Figure 1. Schematic flowsheet of combined utilisation of coal for petroleum substitute production, ironmaking and power generation.

Pyrolysis process can be carried out at ambient pressure and temperature of 550-650 °C. A review of different technologies for coal pyrolysis can be found in a monograph[1]. Figure 2 illustrates a fast pyrolysis process proposed in literature[2] and the change of recovery of liquid fuel with pyrolysis temperature and time. In this process, heat of pyrolysis is provided by partial combustion of char. This process is very simple and cost-efficient.



(a) (b)

Figure 2. Schematic flowsheet of a coal pyrolysis process (a) and the liquid fuel yield (b)

Current blast furnaces and coal fired power generation plants use pulverised coal as fuel. Using pulverised char to replace pulverised coal will provide the following advantages to these processes: (1) saving energy of coal grinding and enhancing combustion efficiency; (2) increasing the safety of the pulverisation operation and pulverised char storage, and making the transport of the carbonaceous materials more reliable; (3) potentially, replacing pulverised coal injection by injecting char may make blast furnace operation more stable and more productive; (4) increasing the completeness of combustion of carbon.

Integration of various industries in coal utilisation provides a route for efficient utilisation of coal resources which does not need high investment in technology development and building up new plants, and will generate significant economic benefits to the industrial operators. This is especially important when the related industries are under the pressure of increasing their operation costs under the Carbon Trade Systems.

References

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